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⑯ Pedicle screw clamp.

⑯ A pedicle screw clamp (9) comprising two sections (14,16) adapted to form a socket (8) which receives the head (7) of a pedicle screw (12), a hook (20) which holds a spinal support rod (10) at an adjustable distance from the socket (8) and com-

pression means (33) which holds the two sections (14,16) together so that they tightly clamp the head (7) of the pedicle screw (12).

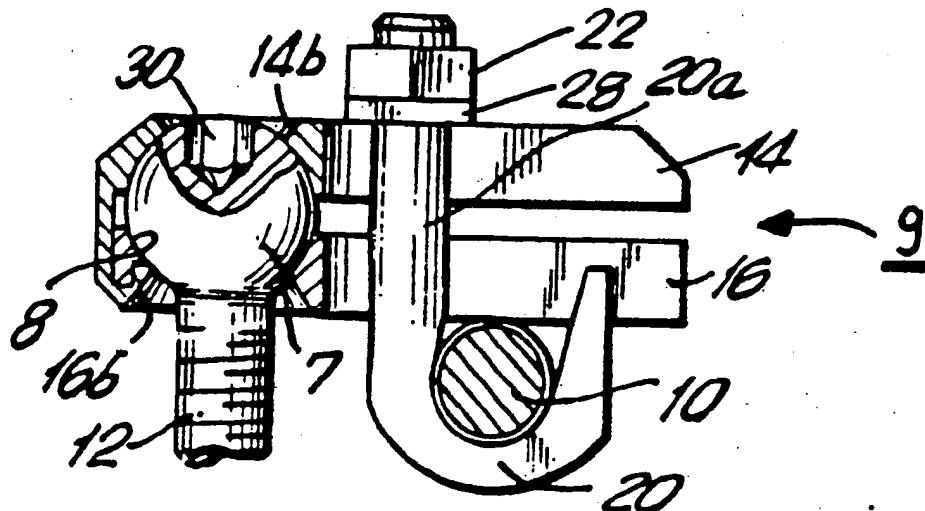


FIG.3

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PEDICLE SCREW CLAMP

Field of the Invention

This invention relates to an osteosynthetic clamp according to the preamble of claim 1 and a fixation assembly according to the preamble of claim 17.

Background of the Invention

Pedicle screws held by clamps in osteosynthetic assemblies are one type of implant used for treating spinal injuries and deformities. In one common treatment the pedicle screws are driven into the pedicles of vertebrae above and below the injured vertebra or vertebrae. A supporting rod is attached to the pedicle screws, for example, by clamps or by threading it through slots in the pedicle screws. The supporting rod holds the spinal column approximately in its desired alignment, thereby relieving pressure on the injured vertebra or vertebrae and permitting it to heal and regain its natural conformation.

One type of pedicle screw is disclosed in U.S. patent application serial no. 163,278, filed March 2, 1988.

As noted, clamps may be used to connect rigidly the part of the pedicle screw protruding from the vertebra to a spinal support rod. In most of these known clamps the pedicle screw and the supporting rod are arranged in the same plane allowing no adjustment to anatomical requirements. In another known type of pedicle screw clamp (according to AT-B 387.710 SULZER) the central axis of the pedicle screw and the central axis of the support rod are located in different planes but still maintained at a fixed, non-adjustable distance, again preventing the surgeon to adapt the clamp to anatomical needs. Furthermore these known pedicle screw clamps do not permit relative angular adjustment of the pedicle screw and the support rod. Thus, current clamps do not allow sufficient adjustment to the specific alignment required by each patient's need.

Summary of the Invention

The invention as claimed is intended to remedy these drawbacks. It solves the problem of how to design an osteosynthetic clamp for attaching a pedicle screw or spinal hook to a spinal support rod with an adjustable distance between the central axis of the pedicle screw and the central axis of the support rod, and at the same time permitting an-

angular adjustment of the central axis of the pedicle screw relative to the central axis of the support rod.

The invention solves the problem with a clamp comprising the features of claim 1 and a fixation assembly comprising the features of claim 14.

In a preferred embodiment the clamp may comprise two sections adapted to receive the head of a pedicle screw, a hook which holds the support rod at an adjustable distance from the pedicle screw and compression means which holds the two sections together so that they tightly clamp the head of the pedicle screw.

In one aspect the invention comprises a clamp having a jaw with upper and lower sections, hinged at one end, said sections being bifurcated to form a slot extending through the sections, a socket formed in the jaw for receiving the head of a pedicle screw and compression means movable relative to said socket for forcing the jaws together, said compression means being adapted to receive a support rod and being operable to urge said rod against the jaw as the jaw sections are forced together.

In another aspect the invention comprises a clamp having a jaw with an upper section and a shorter section, hinged at one end, said upper section being bifurcated to form a slot extending through it, a socket formed in the jaw for receiving the head of a pedicle screw, receiving means which receives a support rod and holds the support rod against the lower surface of the upper section, and compression means, such as a screw extending through the upper and lower sections, which forces them together so as to grasp the head of the pedicle screw.

In another aspect the invention comprises a clamp having front and back section which form a socket for the pedicle screw head, the front section having a bifurcated extension. The clamp further comprises receiving means which receives a support rod and compression means, such as a screw which holds the front and back sections together, grasping the head of the pedicle screw. In another the invention includes a fixation assembly comprising a clamp as described, a pedicle screw having a head shaped to engage the socket and a support rod.

In a further aspect the invention comprises clamp having a front and a back section forming one single block, the front section having a hollow-cylindrical bore for receiving the support rod and the back section having a slot for adjustably receiving the head region of a pedicle screw.

In still another aspect the invention comprises a clamp having a front and a back section forming

one single element, the front section being bifurcated to form a slot extending through it, the back section forming a spherical head for rotatable fixation in the head region of a pedicle screw.

The advantages offered by the invention are mainly the following:

- ease of manipulation for the surgeon
- adaptability of the system, due to the fact that each pedicle screw may be placed at a different distance from the support rod
- possibility to use not only deformable support rods, but also rigid support rods which offer an increased mechanical strength

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. For the better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which are illustrated and described preferred embodiments of the invention.

Brief Description of the Drawings

In the drawings:

- Fig. 1 is a side elevational view of a fixation assembly comprising a clamp according to the invention showing the support rod in cross-section;
- Fig. 2 is a plan view of the fixation assembly of Fig. 1;
- Fig. 3 is a side view of the fixation assembly of Figs. 1 and 2, partially cut away to show the entire head of the pedicle screw;
- Fig. 4 is a side view of another embodiment of a fixation assembly comprising a clamp according to the invention;
- Fig. 5 is a plan view of the clamp and pedicle screw of Fig. 4;
- Fig. 6 is a perspective view of another embodiment of a fixation assembly comprising a clamp according to the invention;
- Fig. 7 is a top view of the clamp of Fig. 6.
- Fig. 8 is a perspective view of another embodiment of a fixation assembly comprising a clamp according to the invention;
- Fig. 9 is a vertical sectional view through the pedicle screw of the assembly of Fig. 8;
- Fig. 10 is a vertical sectional view through the clamp of the assembly of Fig. 8;
- Fig. 11 is a horizontal sectional view through the clamp of the assembly of Fig. 8;
- Fig. 12 is a top view of another embodiment of a partial fixation assembly comprising a clamp according to the invention;
- Fig. 13 is plan view of the clamp of the assem-

bly of Fig. 12;

Fig. 14 is a side view of the clamp of the assembly of Fig. 12;

Fig. 15 is a frontal sectional view through the pedicle screw of the clamp of the assembly of Fig. 12;

Fig. 16 is a lateral sectional view through the pedicle screw of the clamp of the assembly of Fig. 12;

Fig. 17 shows the fixation of the clamp of the assembly of Fig. 12 in the head region of the pedicle screw of Fig. 16;

Fig. 18 is a lateral view of the partial assembly of Fig. 17.

Fig. 19 is an exploded view of a preferred embodiment of a fixation assembly according to the invention;

Fig. 20 is plan view of the clamp of the assembly of Fig. 19;

Fig. 21 is a side view of the clamp of the assembly of Fig. 19;

Fig. 22 is a top view of the hook of the assembly of Fig. 19;

Fig. 23 is a side view of the hook of the assembly of Fig. 19; and

Fig. 24 is a perspective view of the assembly of Fig. 19.

Description of the Preferred Embodiments

As shown in Fig. 1, a clamp 9 according to the invention holds a support rod 10, which is preferably threaded, and a pedicle screw 12 in a fixed position, more or less perpendicular to each other. The clamp 1 comprises a jaw 9a having an upper section 14 and a lower section 16, connected to each other by a C-shaped extension 14a of the upper section 14 which engages a flange 16a of the lower section 16 to form a hinge 18. Towards their ends near hinge 18, upper and lower sections 14 and 16 are shaped to form a socket 8 (as represented in Fig. 3) adapted to accommodate the head 7 of the pedicle screw 12. In preferred embodiment of the assembly comprising a clamp according to the invention as shown in Fig. 3, the pedicle screw 12 has an essentially spherical head 7. The upper section 14 of jaw 9a has an aperture 14b providing access to the screw head 7. Lower section 16 has an aperture 16b to accommodate the shaft of the pedicle screw 12.

The surface of the head 7 of pedicle screw 12 may be roughened to provide better grip by the clamp 9. The inner surfaces of the socket 8 which holds the head 7 may also be roughened.

Compression means are provided to press the upper and lower sections 14 and 16 of the jaw 9a together. As shown in Figs. 1 to 3 the compression

means may be a hook 20. As shown in Fig. 2 and 3, the upper and lower sections 14 and 16 are bifurcated to provide a slot 26. The shaft 20a of hook 20 passes through this slot 26. the bight 20b of hook 20 forms a space under lower section 16 adapted to receive a support rod 10. The inner surface of bight 20b may be threaded or otherwise roughened to engage threads or a roughened surface on support rod 10. The lower surface of lower section 16 may be threaded, knurled or otherwise roughened in the area where it contacts support rod 10, in order to engage threads or the like on the support rod 10. The textured surfaces provide for a better grip on the support rod 10, which must be held firmly in place. The upper surface of upper section 14 has toothed areas 24 along the sides of through slot 26. A small retaining plate 28 with teeth 28a on one surface rests on top of and bridges the toothed areas 24, with the two sets of teeth interlocking. The distance between the axis of shaft 20a of hook 20 and the central axis of pedicle screw 12 can be varied by moving the small toothed plate 28 along the length of through slot 26. Nut 22 is threaded on the hook shaft 20a on top of plate 28. Tightening nut 22 locks plate 28 and hook 20 into the desired place along through slot 26.

In using the device according to the invention, the pedicle screw 12 is first run through the aperture 16b in the lower jaw section 16 and inserted into the bone, using the hexagonal socket 30 in the head 7 of the pedicle screw 12 to receive a suitable tool. The upper section 14 is then engaged with lower section 16 to form a jaw 9a. Hook 20 is loosely inserted in through slot 26 and the support rod 10 inserted in the bight 20b of the hook 20, the hook 20 being moved along the through slot 26 to the desired position. When pedicle screw 12 and support rod 10 are at the optimum distance from one another and at the proper angle, nut 22 is turned down on the shaft 20a of the hook 20, forcing the jaw sections 14 and 16 together to clamp the head 7 of the pedicle screw 12 in this socket 8 and press support rod 10 firmly against lower section 16. The leverage provided by the jaw construction 9a enables the pedicle screw 12 to be tightly fixed in its selected position relation to the support rod 10.

Another embodiment of the invention is shown in Figs. 4 and 5. Clamp 35 comprises a bifurcated upper section 36 and a lower section 37, connected to each other by a hinge 38 with a pin 39. On one side of pedicle screw 12 opposite the hinge 38 are two threaded screws 40. These screws hold upper section 36 and lower section 37 together, thus locking the head 7 of pedicle screw 12 in place. Fig. 5 shows two screws 40, but in alternative embodiment, a single screw 40 may be used.

Lower section 37 is shorter than upper section 36, as shown in Fig. 4. A hook 20 as described in connection with Figs. 11 - 3 passes through the slot 26 formed by the bifurcation of upper section 36 and holds a support rod 10 against the lower surface of upper section 36. It should be evident that the configuration of the toothed upper surface 24, small retaining plate 28 and nut 22 described in connection with Figs. 1 - 3 are applicable to this embodiment as well.

The manner of use of the embodiment according to Figs. 4 and 5 is parallel to that according to Figs. 1 - 3.

Another embodiment of the invention is shown in Figs. 6 and 7. In this embodiment the head 7 of the pedicle screw 12 instead of being clamped by two hinged elements is held between two sections of a block which are joined by screws or bolts. Referring to Fig. 6, the clamp in this embodiment comprises a block 50 having a front section 44 and a back section 46. Front section 44 has a bifurcated extension 45 which forms a slot 26. As shown in Fig. 6 a hook 20, support rod 10, toothed upper surface 24, small toothed plate 28 and nut 22 are provided as described above in connection with Figs. 1 - 5. Front section 44 has two screw holes 49 through it. As shown in Fig. 6, these screw holes 49 are at an angle of about 45° to the top surface of the clamp or the axis of the pedicle screw 12 to be retained in the clamp. These screw holes 49 continue into back section 46 at the same angle. In a preferred embodiment, only the parts of screw holes 49 which are in the back section 46 are threaded, while screws 47 may be partially or wholly threaded. Front and back sections 44 and 46 are shaped to form a socket 48 which accommodates the head 7 of a pedicle screw 12. Engagement of screws 47 into the threaded holes in back section 46 forces the back section 46 against front section 44 and secures pedicle screw 12 in its desired position.

When using this embodiment of the invention, the pedicle screw 12 is first inserted into the bone. Front section 44 is placed on the front of the screw head 7, with a hook 20 inserted in slot 26 and the support rod 10 held in the bight of the hook 20. When the pedicle screw 12 and the support rod 10 are adjusted to the optimum distance and angle, back section 46 is placed on the back of the pedicle screw head 7. Screws 47 are inserted into screw holes 49 and tightened. In the embodiment shown in Fig. 6, screws 47 have hexagonal holes in their heads to receive a tool for tightening them. The 45° degree angles make it easier for the surgeon to reach the screws 47. In an alternative configuration (not shown) the screws 47 are put in straight from back section 46 to front section 44, with the axis of the screw holes 49 parallel to the

bifurcated extension 45 or generally perpendicular to the axis of the pedicle screw 12.

The ends of extension 45 may be flanged as shown in Fig. 6, or they may have a simple rectangular cross-section, on any of the embodiments of the invention.

Another embodiment of the invention is shown in Figs. 8 and 11. In this embodiment the clamp 60 has a front section 54 and a back section 56 forming one single block, the front section 54 having a hollow-cylindrical bore 53 for receiving the support rod 10 and the back section 56 having a slot 51 for adjustably receiving the head region 57 of a pedicle screw 52.

The bore 53 can either have a smooth surface or preferably a structured surface (threads or longitudinal grooves), at least on the side opposite screw hole 61, said structured surface being similar to corresponding structures on the surface of support rod 10. Upon fastening of screw 59 support rod 10 is pressed against the structured surface of bore 53 thereby producing a firm fixation.

The head region 57 of the pedicle screw 52 is designed as a threaded cylinder insertable into the longitudinal slot 51 of the back section 56 and which can be adjustably secured against back section 56 of the clamp 60 by means of the nut 58. For the ease of insertion of the pedicle screw 52 the head region 57 is provided with a central hexagonal bore 62.

Fixation of the support rod 10 occurs by means of the screw 59 in the screw hole 61 of the front section 54 of the clamp 60, allowing the releaseable fixation - against longitudinal and rotational movement - of the support rod 10 with respect to the clamp 60.

Another embodiment of the invention is shown in Figs. 12 and 18. In this embodiment the clamp 70 is similar to clamp 35 of Fig. 5; the difference being that the head of the pedicle screw is not clamped by suitable elements of the clamp but is incorporated in the clamp 70 itself for being fixed into the head of the pedicle screw.

Clamp 70 therefore has a front section 64 and a back section 66 forming one single element, the front section 64 being bifurcated - in the same way as clamp 35 of Fig. 5 - to form a slot 71 extending through it, the back section 66 forming a spherical head for rotatable fixation in the head region 77 of a pedicle screw 72.

The head region 77 of the pedicle screw 72 has a frontally accessible socket 73 into which the spherical head of the back section 66 of the clamp 70 can be inserted and secured by means of the central screw 74. Central screw 74 can be tightened by means of the central hexagonal bore 75 into a corresponding screw hole 76 in the head region 77. Fixation of the spherical head 66 in the

socket 73 occurs by means of two anchoring points incorporated in the lower half of the head region 77 and third anchoring point 79 incorporated in the lower surface of the central screw 74. Socket 73 has circular back opening 81 and a circular front opening 82, said back opening 81 having a diameter inferior to the diameter of the spherical head 66 and said front opening 82 having a diameter superior to the diameter of the spherical head 66. By this construction the spherical head 66 can be safely fixed in the socket 73 - as shown in Fig. 17 - by means of the points 78, 79 against the annular rim 83 of back opening 81.

As shown in Fig. 18 this embodiment of the invention allows the angular adjustment of the clamp 70 with relation to the pedicle screw 72.

Fixation of the support rod 10 is achieved in the same way as for clamp 35 of Fig. 4 by means of suitable hook 20 as described in connection with Figs. 1 - 3 which passes through the slot 71 formed by the bifurcation of front section 64 and holds a support rod 10 against its lower surface. It should be evident that the configuration of the toothed upper surface 24, small retaining plate 28 and nut 22 described in connection with Figs. 1 - 3 are applicable to this embodiment as well.

Still another embodiment of the invention is shown in Figs. 19 to 24. In this embodiment clamp 90 is somewhat similar to clamp 70 of Fig. 13; the difference being that the bifurcated front section 84 is not connected to a spherical head but to a longitudinal cylindrical section which is provided with threads. Clamp 90 therefore has a front section 84 and a back section 86 forming one single element, the front section 84 being bifurcated - in the same way as clamp 70 of Fig. 13 - to form a slot 91 extending through it, the back section 86 forming a longitudinal cylindrical section 86 which is provided with threads for fixation in the head region 97 of a pedicle screw 92.

The head region 97 of pedicle screw 92 is also bifurcated forming a canal 85 for receiving the back section 86 of clamp 90, which can be secured by means of the screw cap 93. Screw cap 93 has preferably a (not-represented) coaxial inner cylindrical portion with reduced diameter which is threaded at its surface for engagement into the inner thread 87 of the bifurcated head region 97 of the pedicle screw 92. Screw cap 93 may be fastened to the head region 97 by means of a hexagonal screw driver engaging with the hexagonal bore 88 of screw cap 93.

Fixation of the support rod 10 is achieved in a similar way as for clamp 35 of Fig. 4 by means of a suitable hook 94 as described in connection with Figs. 1 - 3. The hook 94 has a threaded portion 95 in the inner concavity of its curved portion 99 and an outer threaded portion 98 on its straight portion.

100. The straight portion 100 of the hook 94 passes through the slot 91 formed by the bifurcation of front section 84 and upon fixation with the nut 96 on the threaded portion 98 holds a support rod 10 against its lower threaded surface 95. It should be evident that the configuration of the toothed upper surface 24, small retaining plate 28 and nut 22 described in connection with Figs. 1 - 3 are applicable to this embodiment as well.

The various surfaces described in connection with Figs. 1 - 3, as being roughened to provide better grip may of course be employed in the other embodiments too.

From a consideration of the foregoing description it will be evident that a clamp according to the invention permits movement of the support rod relative to the pedicle screw. The surgeon can therefore regulate the horizontal distance between the pedicle screw and the support rod. Because the spherical head of the pedicle screw may be tilted in its socket the angle between the pedicle screw and the support rod may also be adjusted. Thus the clamp according to the invention permits the surgeon to adjust each pedicle screw to the specific configuration required by a particular patient.

Although the invention has been described as applied to a pedicle screw, it is clearly also applicable to other similar devices such as spinal hooks.

Claims

1. An osteosynthetic clamp (9;35) for attaching a pedicle screw (12) or spinal hook to a spinal support rod (10) wherein the central axis (6) of said pedicle screw (12) or spinal hook and the central axis (5) of said spinal support rod (10) are located in different planes, characterised in that means are provided allowing the adjustable clamping of said pedicle screw (12) or spinal hook with respect to said spinal support rod (10) such that the relative position of the said two axis (5,6) in said planes is adjustable.

2. Clamp according to claim 1, characterised in that it comprises:

a first section (14) and a second section (16), at least one of said section (14) being bifurcated to form a through slot (26),
 a socket (8) formed in said first and second sections (14,16) for receiving the head (7) of a pedicle screw (12), receiving means (4) adapted to receive a support rod (10), said receiving means (4) being movable relative to said socket (8), and
 compression means (22) for forcing said two sections (14,16) together to grasp the head (7) of a pedicle screw (12) lodged in said socket (8).

3. Clamp according to claim 1, characterised in that it comprises:

a jaw having an upper section (36) and a lower section (37), said lower section being preferably shorter than said upper section (36), hingedly (38,39) connected to each other, preferably at one of their ends, one of said sections (36,37) at least being bifurcated to form a slot (26) extending through at least one of said sections (36,37),

10 a socket (8) formed in said jaw for receiving the head (7) of a pedicle screw (12),
 first compression means (22) movable relative to said socket (8), said compression means (22) being adapted to receive a support rod (10) and to urge said support rod (10) against the upper section (37) of said jaw; and

15 second compression means (40), for forcing the sections (36,37) of said jaw together to grasp the head (7) of a pedicle screw (12) lodged in said socket (8).

4. Clamp according to claim 1, characterised in that it comprises:

a front section (44) and a back section (46) forming a block (50), said front section (44) being provided with a through slot (26), preferably forming a bifurcation of said front section (44),

20 a socket (48) formed in said front and back sections (44,46) for receiving the head (7) of a pedicle screw (12), receiving means (4) adapted to receive a support rod (10), said receiving means (4) being movable relative to said socket (8), and
 compression means comprising one or more screws (47) adapted to fit into one or more screw holes (49) extending from one section (44) into the other section (46) for forcing said two sections (44,46) together to grasp the head (7) of a pedicle screw (12) lodged in said socket (8).

5. Clamp according to claim 1, characterised in that it comprises:

25 a front section (64) and a back section (66), said front section (64) being bifurcated to form a through slot (71) and said back section (66) being of spherical shape for fixation into the head region (77) of a pedicle screw (72), receiving means (4) adapted to receive a support rod (10), said receiving means (4) being movable relative to said front section (64), and
 compression means (74) for fixing said spherical back section (66) within the head region (77) of a pedicle screw (72).

30 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 1235 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3240 3245 3250 3255 3260 3265 3270 3275 3280 3285 3290 3295 3300 3305 3310 3315 3320 3325 3330 3335 3340 3345 3350 3355 3360 3365 3370 3375 3380 3385 3390 3395 3400 3405 3410 3415 3420 3425 3430 3435 3440 3445 3450 3455 3460 3465 3470 3475 3480 3485 3490 3495 3500 3505 3510 3515 3520 3525 3530 3535 3540 3545 3550 3555 3560 3565 3570 3575 3580 3585 3590 3595 3600 3605 3610 3615 3620 3625 3630 3635 3640 3645 3650 3655 3660 3665 3670 3675 3680 3685 3690 3695 3700 3705 3710 3715 3720 3725 3730 3735 3740 3745 3750 3755 3760 3765 3770 3775 3780 3785 3790 3795 3800 3805 3810 3815 3820 3825 3830 3835 3840 3845 3850 3855 3860 3865 3870 3875 3880 3885 3890 3895 3900 3905 3910 3915 3920 3925 3930 3935 3940 3945 3950 3955 3960 3965 3970 3975 3980 3985 3990 3995 4000 4005 4010 4015 4020 4025 4030 4035 4040 4045 4050 4055 4060 4065 4070 4075 4080 4085 4090 4095 4100 4105 4110 4115 4120 4125 4130 4135 4140 4145 4150 4155 4160 4165 4170 4175 4180 4185 4190 4195 4200 4205 4210 4215 4220 4225 4230 4235 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8240 8245 8250 8255 8260 8265 8270 8275 8280 8285 8290 8295 8300 8305 8310 8315 8320 8325 8330 8335 8340 8345 8350 8355 8360 8365 8370 8375 8380 8385 8390 8395 8400 8405 8410 8415 8420 8425 8430 8435 8440 8445 8450 8455 8460 8465 8470 8475 8480 8485 8490 8495 8500 8505 8510 8515 8520 8525 8530 8535 8540 8545 8550 8555 8560 8565 8570 8575 8580 8585 8590 8595 8600 8605 8610 8615 8620 8625 8630 8635 8640 8645 8650 8655 8660 8665 8670 8675 8680 8685 8690 8695 8700 8705 8710 8715 8720 8725 8730 8735 8740 8745 8750 8755 8760 8765 8770 8775 8780 8785 8790 8795 8800 8805 8810 8815 8820 8825 8830 8835 8840 8845 8850 8855 8860 8865 8870 8875 8880 8885 8890 8895 8900 8905 8910 8915 8920 8925 8930 8935 8940 8945 8950 8955 8960 8965 8970 8975 8980 8985 8990 8995 9000 9005 9010 9015 9020 9025 9030 9035 9040 9045 9050 9055 9060 9065 9070 9075 9080 9085 9090 9095 9100 9105 9110 9115 9120 9125 9130 9135 9140 9145 9150 9155 9160 9165 9170 9175 9180 9185 9190 9195 9200 9205 9210 9215 9220 9225 9230 9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9375 9380 9385 9390 9395 9400 9405 9410 9415 9420 9425 9430 9435 9440 9445 9450 9455 9460 9465 9470 9475 9480 9485 9490 9495 9500 9505 9510 9515 9520 9525 9530 9535 9540 9545 9550 9555 9560 9565 9570 9575 9580 9585 9590 9595 9600 9605 9610 9615 9620 9625 9630 9635 9640 9645 9650 9655 9660 9665 9670 9675 9680 9685 9690 9695 9700 9705 9710 9715 9720 9725 97

plate (28) on the upper surface of one section (14), said retaining plate (28) having a hole to receive the shaft (20a) of the hook (20).

8. Clamp according to claim 7, characterised in that it comprises further a nut (22) on the end of the shaft (20a) of the hook (20) for holding the retaining plate (28) against the upper surface of one section (14).

9. Clamp according to one of the claims 6 to 8, characterised in that the retaining plate (28) and the upper surface of one section (14) have toothed areas (28a,24) adapted to engage one another.

10. Clamp according to one of the claims 2 to 9, characterised in that the socket (8) is adapted to receive a spherical-headed pedicle screw (12).

11. Clamp according to one of the claims 2 to 10, characterised in that the socket (8) has roughened surfaces.

12. Clamp according to one of the claims 6 to 11, characterised in that a surface of the bight (20b) of the hook (20) is threaded for engagement with threads of a support rod (10).

13. Clamp according to one of the claims 2 to 12, characterised in that one of said sections (16;46) has a roughened surface for contact with a support rod (10).

14. Clamp according to claim 4, characterised in that said screw holes (49) extend from the front section (44) into the back section (46) at an angle of approximately 45° to the axis (6) of the pedicle screw (12).

15. Clamp according to claim 1, characterised in that it comprises:

a front section (54) and a back section (56) forming one single block (60), the front section (54) having a hollow-cylindrical bore (53) for receiving a support rod (10) and the back section (56) having a slot (51) for adjustably receiving the head region (57) of a pedicle screw (52),

compression means (58) for fixing said head region (57) of said pedicle screw (52) inserted in said slot (51) relative to said back section (56), and

compression means (59,61) for fixing said support rod (10) inserted in said bore (53) relative to said front section (54).

16. Clamp according to claim 1, characterised in that it comprises:

a front section (84) and a back section (86) forming one single element, the front section (84) being provided with a through slot (91), preferably forming a bifurcation of said front section (84), and said back section (86) being of longitudinal cylindrical shape for fixation into the head region (87) of a pedicle screw (92),

receiving means (94) adapted to receive a support rod (10), compression means (93) for fixing said longitudinal cylindrical back section (86) within the head region (87) of a pedicle screw (92); and

compression means (96) for fixing said support rod (10) inserted in said receiving means (94) relative to said front section (84).

17. Fixation assembly with a clamp (9;35) according to one of the claims 1 to 16, characterised in that it comprises further a support rod (10); and a pedicle screw (12).

18. Assembly according to claim 17 characterised in that the pedicle screw (12) has a spherical head (7).

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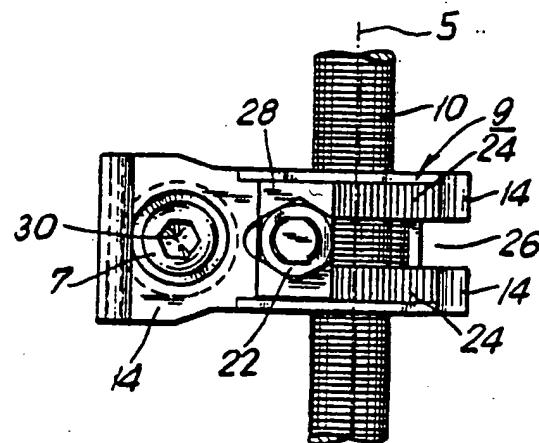


FIG. 2

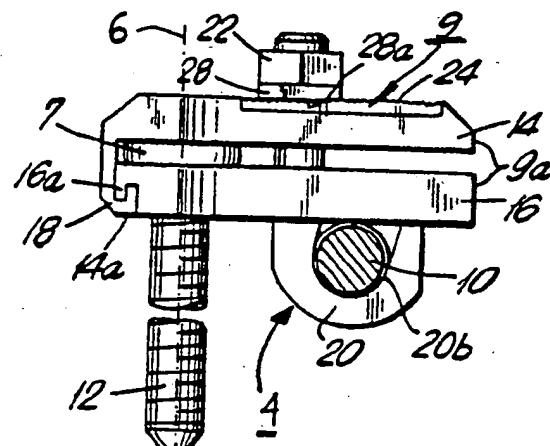


FIG. 1

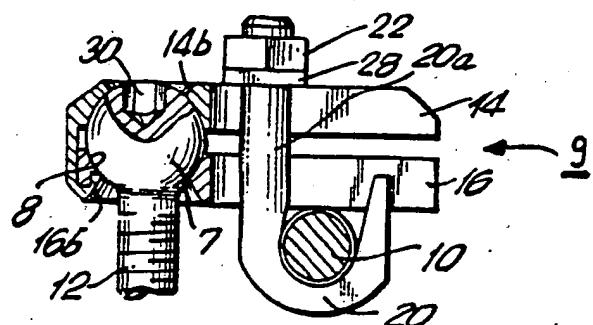


FIG. 3

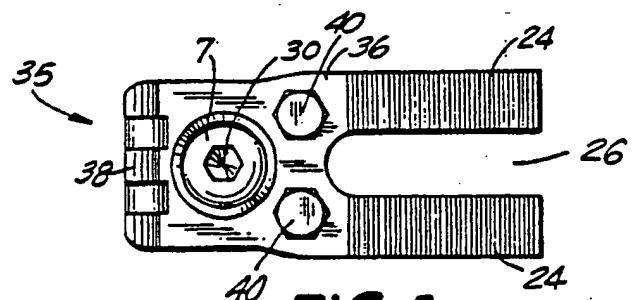


FIG. 5

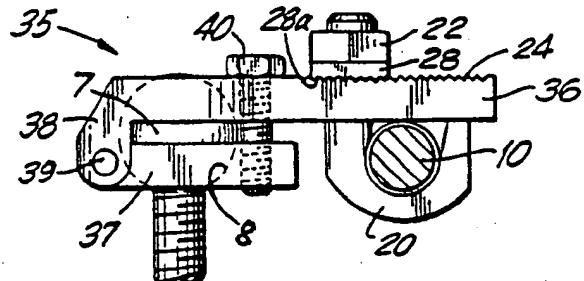


FIG. 4

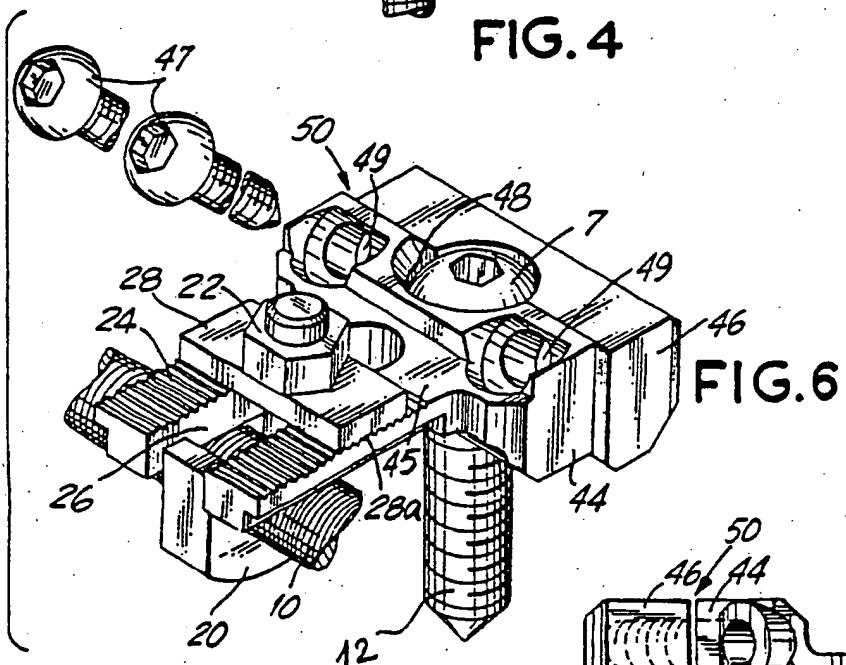


FIG. 6

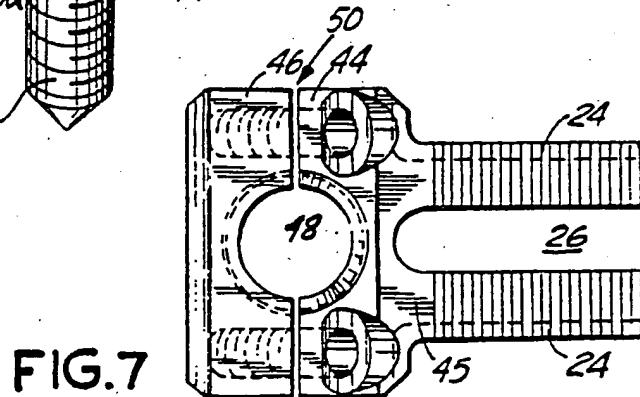


FIG. 7

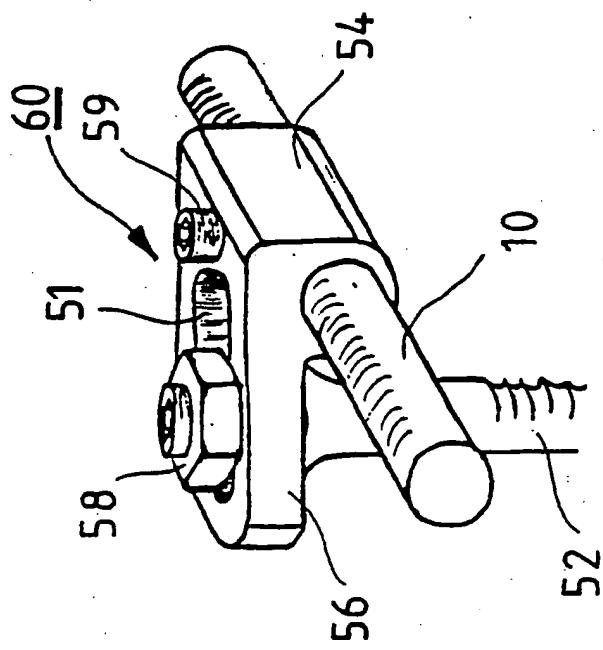


Fig. 8

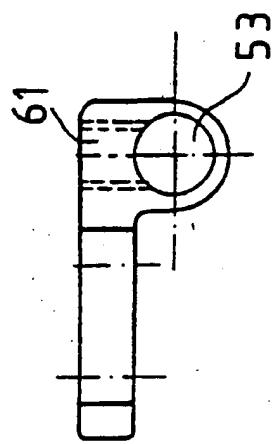


Fig. 10

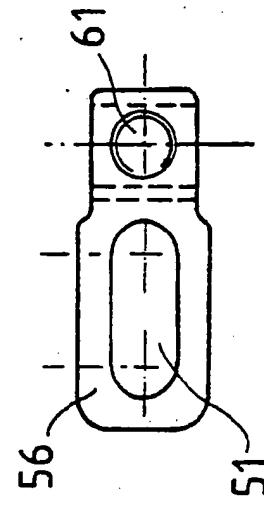


Fig. 11

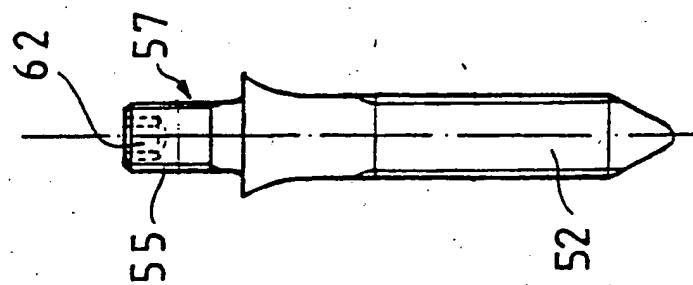


Fig. 9

Fig. 12

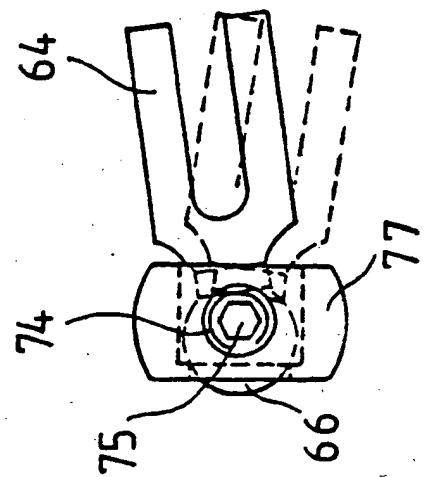


Fig. 14

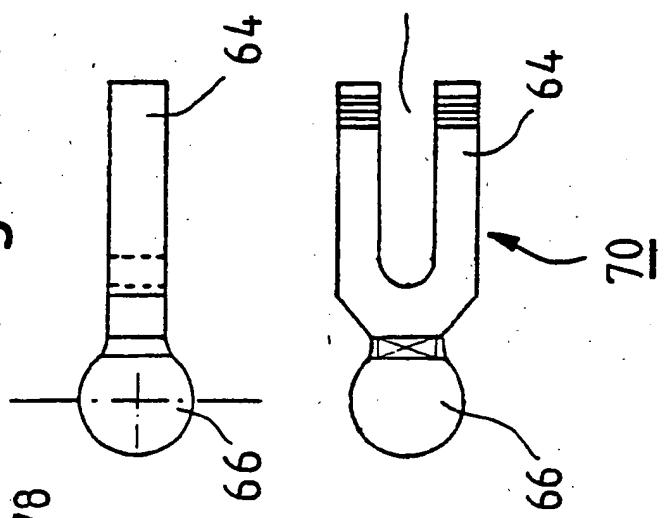
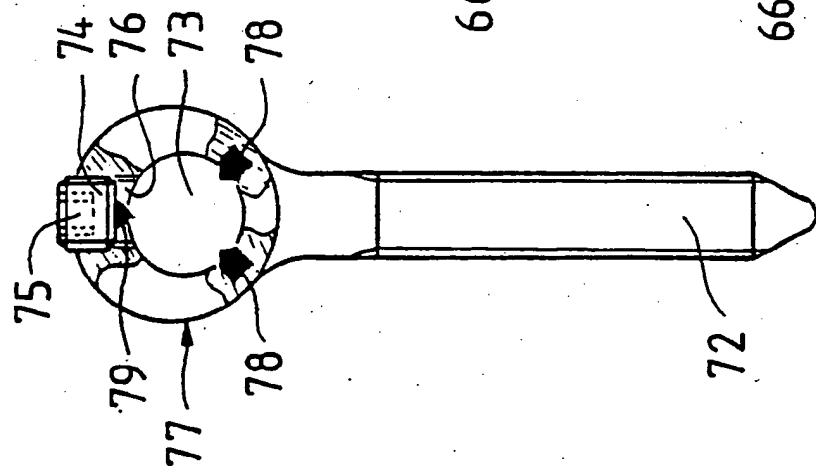


Fig. 13

Fig. 15



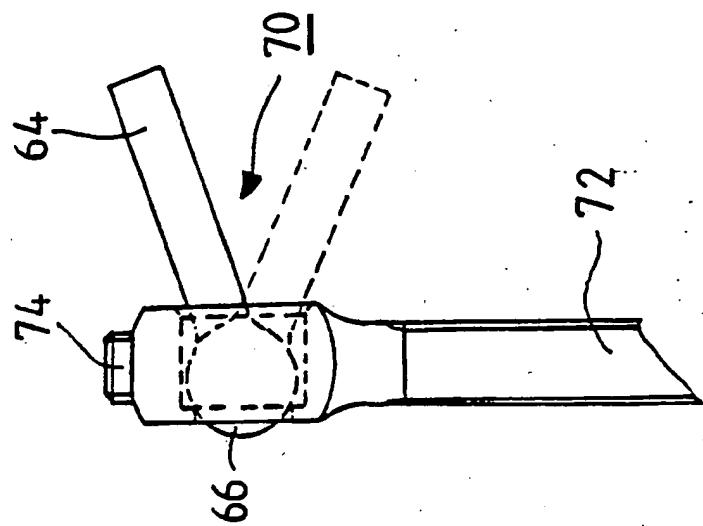


Fig. 18

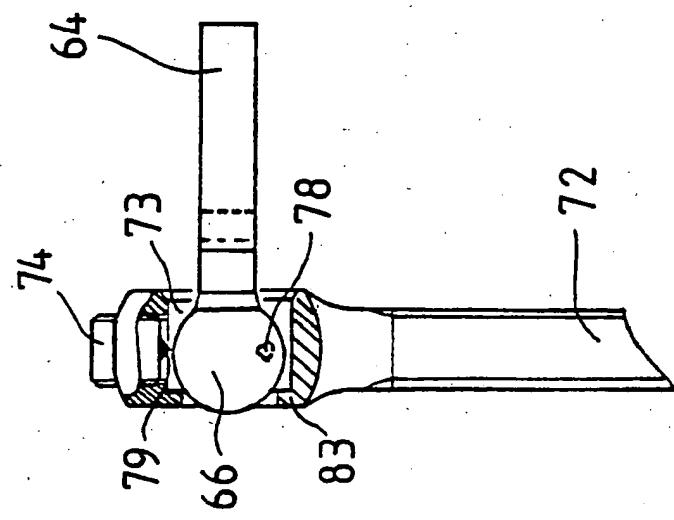


Fig. 17

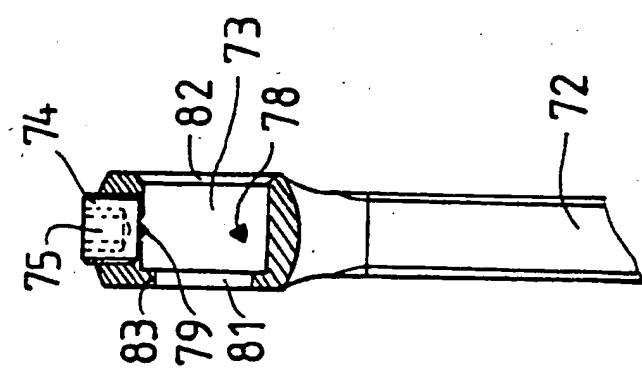


Fig. 16

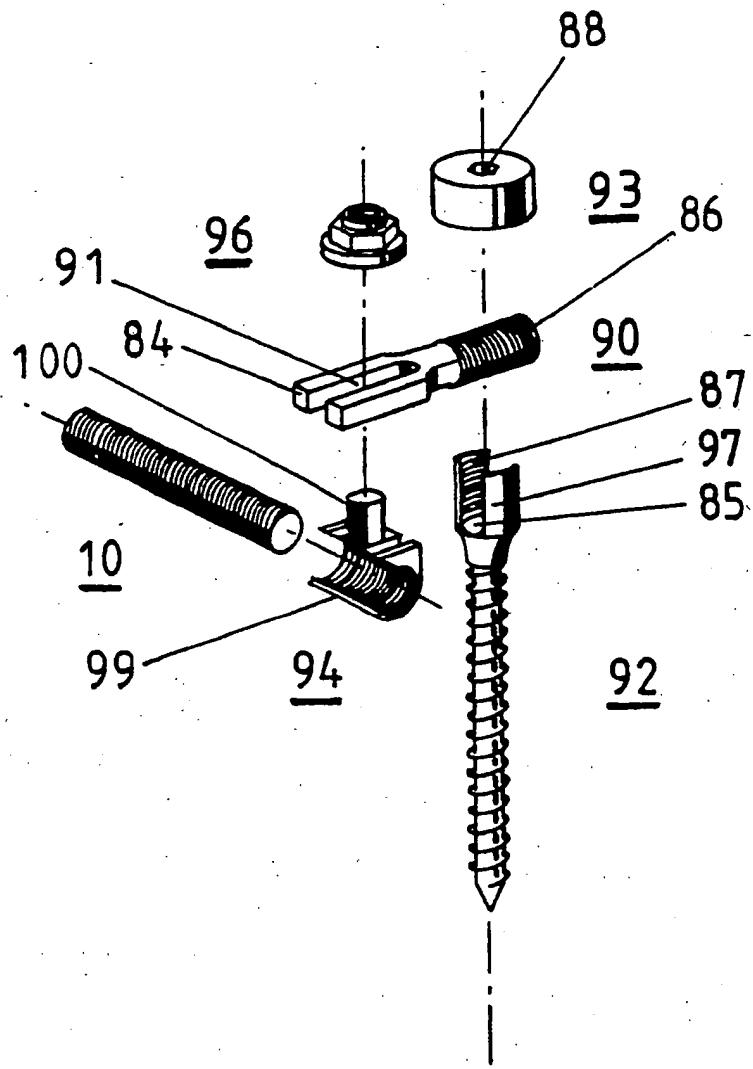


Fig. 19

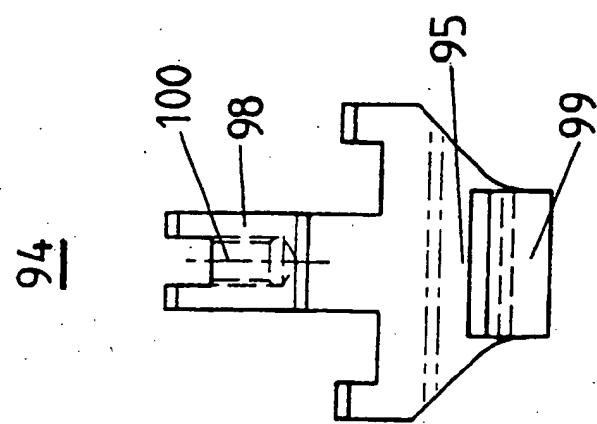


Fig. 23

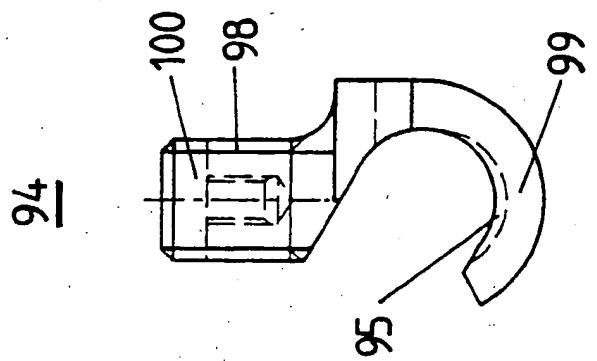


Fig. 22

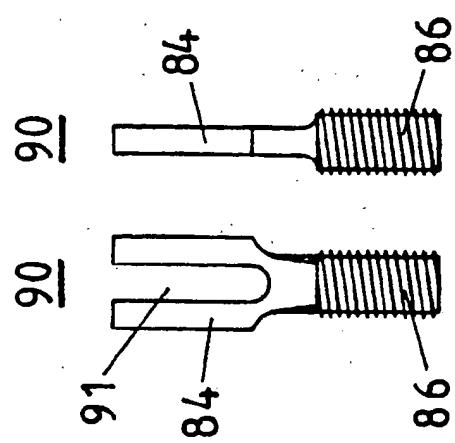


Fig. 20 Fig. 21

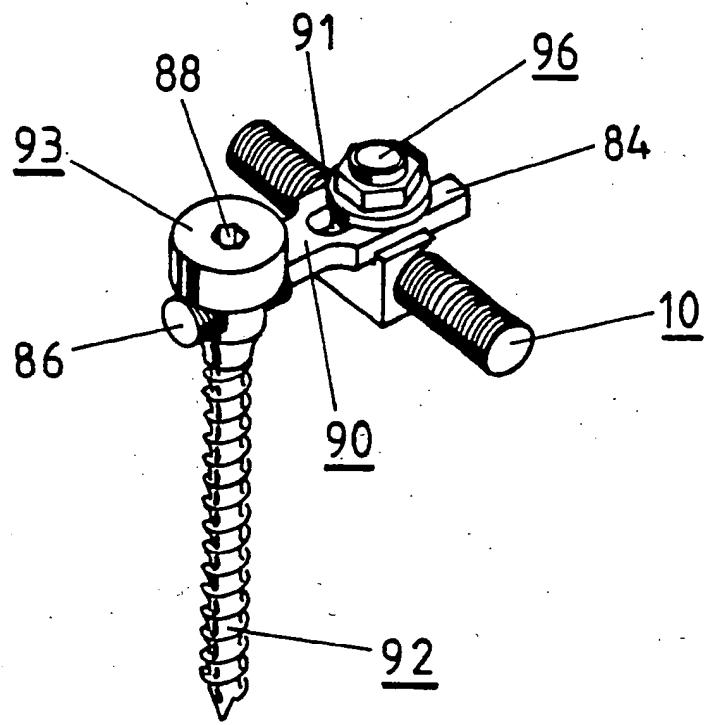


Fig. 24



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 90116070.5
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. CL.5)
X	<u>EP - A2 - 0 242 708</u> (J. HARMS et al.) * Totality; especially fig. 4 *	1, 17, 18	A 61 B 17/56 A 61 F 2/44
A	---	2-5, 10, 15, 16	
X	<u>DE - B2 - 2 834 891</u> (SYNTHES AG) * Totality; especially fig. 1, 2, 4, 5 *	1, 17	
A	---	15	
A	<u>US - A - 4 771 767</u> (A.D. STEFFEE) * Totality; especially fig. 7-9 *	1, 17	
A	<u>US - A - 4 433 676</u> (K.A. BOBECHKO) * Fig. 1-7; abstract; column 2, lines 42-47; column 4, lines 49-54; column 5, lines 11-18 *	1	TECHNICAL FIELDS SEARCHED (Int. CL.5)
A	<u>FR - A1 - 2 615 095</u> (SOC. DE FABR. MAT. ORTH.) * Fig. 2-5; abstract *	1, 17, 18	A 61 B A 61 F
D, A	<u>EP - A1 - 0 330 881</u> (SYNTHES AG) * Fig. 1-3, 6; abstract *	1, 17	
<p>The present search report has been drawn up for all claims</p>			
Place of search VIENNA	Date of completion of the search 12-02-1991	Examiner LUDWIG	
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		I : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	